

The Great Anatomic Misconception: The Central Venous Catheter is in the Axillary Vein, not the Subclavian Vein.

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The anatomy of the human venous system has been accurately known for the past 300 years. Underlying the infraclavicular fossa, there is a major venous structure that is widely known as the “subclavian” vein (SCV); however, for the majority of its course in the infraclavicular fossa, this structure is actually the axillary vein (AXV). When blood leaves the arm it enters the AXV; as it crosses the lateral border of the first rib it enters the SCV (Fig.1) (1), then flows into the brachiocephalic and on into the superior vena cava. The practice of medicine changed in 1952, when the French military surgeon, Robert Aubaniac, published his work on cannulating the SCV

(2). This paper ushered in the era of Central Venous Access (CVA).

Aubaniac describes a very medial approach, tracing the clavicle to the manubrium and then moving laterally to find a fossa immediately adjacent to the sternum. When Aubaniac performed post mortem dissections, he found that his venous catheters entered the subclavian vein near the junction with the brachiocephalic vein (2). The major anatomic significance is that Aubaniac punctured the venous system medial to the lateral border of the first rib, which defines the junction of the AXV with the SCV (Fig. 2a, b). The first rib is a palpable structure in normal-sized people, and the midclavicular line (MCL) is a reasonable anatomic surrogate for the lateral border of the first rib.

Over the past fifty years, a more lateral approach has gained increasing popularity. For most modern central line inserters, the site of skin insertion has moved closer to the humerus than to the sternum (Fig. 3a). At present there are two widely used methods for infraclavicular venipuncture:

1. Using anatomic landmarks, i.e. the clavicle and sternal notch, for guidance.
2. Using portable Ultrasound (US) to visualize the vein and to guide the needle insertion.

In my discussion of the US technique, I contend that it is very difficult (or nearly impossible) to visualize the SCV using portable US (3). Furthermore, since most Ultrasound-assisted insertions utilize a transverse approach, this would involve a very steep angle of trajectory (between 60 and 90 degrees), next

to the sternum (Fig. 4). This does not seem to be a reasonable approach, primarily due to the danger of puncturing the underlying lung. I contend that despite randomized, controlled literature (4, 5, 6), the infraclavicular SCV has *never* been cannulated using portable US (3, 7).

In 1995, Gualtieri et al published a paper entitled, *Ultrasound-guided Subclavian Vein Catheterization: improved success rate for inexperienced inserters* (8).

This paper is the source article for the previously referenced papers, which are meta-analyses (4, 5, 6).

In this paper, Gualtieri shows a diagram of her technique, which clearly shows an AXV puncture (Fig.1). The needle is shown puncturing a venous structure, which is correctly labeled, the AXV. Yet, Gualtieri entitles her paper US-guided *Subclavian*

Vein Cannulation. The only randomized, controlled series comparing infraclavicular US guidance to the anatomic landmarks makes an anatomic mistake. The paper should have been titled, US-guided *Axillary Vein Cannulation*. I believe that *every single* US-guided, infraclavicular central line insertion has been into the *Axillary Vein* and not the SCV (3, 7).

In discussing the traditional anatomic landmark-guided method, we propose that the midclavicular line (MCL) is an excellent surface marker for the lateral border of the first rib (the anatomic junction between the AXV and SCV), and the MCL is generally slightly lateral to the first rib (Fig. 1, 2a). If the CVC punctures the infraclavicular skin medial to the MCL, there is no doubt that the needle/catheter is entering the SCV (Fig. 2a, b). In contradistinction, if the line inserter

punctures the skin lateral to the MCL, then the inserter does not know whether he or she is puncturing the SCV or the AXV (Figs. 1, 3a). It can be appreciated that, due to the oblique angulation of the needle through the subcutaneous tissue, puncturing the skin at the MCL may result in an SCV cannulation. However, the further lateral that one punctures the skin, the more likely it is that the AXV is entered (Fig. 3a, b). Given the modern tendency to enter the skin quite a bit lateral to the MCL (Fig. 3a), it is postulated that the vast majority of landmark-guided infraclavicular central lines are actually AXV catheters rather than SCV catheters.

It would seem reasonable that the radiology literature would describe the AXV approach since the radiologists image 100% of their infraclavicular

venipunctures. The vast majority use US and the minority use venography-fluoroscopy. It is the author's contention that radiologists insert infraclavicular CVC's into the AXV, nearly all of the time, whether they realize it or not. However, the radiologists uniformly label the vein as the SCV (9).

Radiologically, the AXV approach has a distinctive look, especially if the catheter is inserted lateral to the *second* rib (Fig. 3b). At this site, the entrance of the CVC outside the rib cage can be clearly noted, and this cannot be the SCV. This site (lateral to the 2nd rib) is particularly advantageous, since the vein lies in the axillary fat, and the pleura is not immediately subjacent. This is the author's favored location. Likewise, a CVC, entering medial to the 1st rib, is generally recognizable on the radiograph (Fig. 2b). If

the venipuncture occurs close to the outer border of the 1st rib, it can be difficult for the radiologist to make the determination between AXV and SCV. Consequently, most infraclavicular CVC's can be radiologically determined to be either axillary or subclavian, if one recognizes the anatomic boundary.

To recapitulate: 100% of the sonoguided, nearly 100% of the fluro-guided and the great majority of the landmark-guided CVC are actually inserted into the AXV. Essentially, this paper calls into question every SCV paper, which does not specifically describe a puncture site that is medial to the outer border of the 1st rib (or the MCL) (Fig.1, 2).

The practical ramifications of this anatomic misconception are:

1. The AXV is not the SCV. As a parallel, when the vascular surgeon performs the operation, Axillo-femoral arterial bypass, it is not a Subclavian-femoral arterial bypass.

2. The AXV is eminently compressible, whereas the SCV is thought to be uncompressible.

Compressibility is part of the US evaluation, to tell if the structure in question is venous or arterial.

3. If one were to injure the AXV (or axillary artery), the surgical approach is quite a bit simpler than the approach to the SCV (or subclavian artery), which will generally require a thoracotomy for control.

4. When the Centers for Disease Control (11) and the Institute for Healthcare Improvement (12) issue their recommendations that the SCV is the preferred site for non-tunneled CVA, they are inadvertently

advocating blind sticking, since the SCV cannot be accessed with US guidance. This goes against the large body of literature that supports the US-guided CVA as the safer method (4, 5, 6, 10). The author regards this as an unintended consequence based on anatomic misconception.

Furthermore, I believe that since the anatomy of the human venous system has been completely understood for more than three centuries, the scientific literature must be accurate in this matter. Very little knowledge is handed down to succeeding generations of physicians if we misidentify an anatomic structure. At the heart of the matter, this is the issue: does anatomy matter?

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